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JOHN ASBURY ELLIOTT

PHYTOPATHOLOGY

VOLUME XIV NUMBER 3

MARCH, 1924

JOHN ASBURY ELLIOTT

T. F. MANNS

WITH PLATE II

John Asbury Elliott was born in a sod house on the prairies of Western Kansas, December 1, 1887, near the little village of Ness City; he died January 18, 1923, at Washington, D. C., to which city he went directly after attending the A. A. A. S. meetings in Boston. His boyhood was spent largely on a farm near the place of his birth. I can understand every motive that prompted his love for the wild flower, the hop toad, the arrow top, the buffalo trail, the migrating bird, the creeks, the ponds and the prairies. He used to say to his mother, "I don't see why anyone can live anywhere but on the prairie, it is so beautiful." His interest for plants and birds never left him; his love for nature was so great that the glare of the Metropolis never tempted him. As "sidewalks tend to produce city mindedness" so likewise one born in the lap of nature is lead naturewards.

In the fall of 1909, he entered Fairmount College, of Wichita, Kansas, and received his Bachelor's Degree with the highest honors in 1913. As an undergraduate he majored in botany. The year following graduation he held a fellowship in botany at the University of Kansas, and received his Master's Degree in 1914. The next two years he was a Fellow in Plant Pathology at the University of Illinois, and was awarded the degree of Doctor of Philosophy in 1916. In all the institutions he attended he was recognized as a student of remarkable ability. Dr. Elliott began his career as Associate Plant Pathologist at the University of Delaware. In the summer of 1917, he was elected Professor of Plant Pathology in the College of Agriculture and Plant Pathologist of the Experiment Station of Arkansas, which position he held at the time of his illness.

Dr. Elliott was married to Miss Margaret Elizabeth Allen of Wichita, Kansas, on June 10, 1916. He is survived by his wife and two children.

Professor Dwight Isley, Associate Entomologist in the College of Agriculture, Arkansas, made the statement:—"As an investigator, Dr.

Elliott was characterized by a thorough appreciation of the fundamentals of his science, coupled with common sense. By this somewhat rare combination, he avoided both the narrowness and isolation so often associated with the technical specialist and the superficiality which sometimes characterizes the practical worker. His mind was broad enough to comprehend at the same time both the basic and applied aspects of the problem. One or two illustrations since coming to Arkansas will illustrate this:

"One of the first problems undertaken by Dr. Elliott was the prevention of losses which sweet potato growers suffer annually, due particularly to two diseases known as black rot and wilt. It was established that both these diseases were spread by infected seeds and slips. According to the practice then in vogue, anyone buying seed or slips had no protection from these diseases but was likely at any time to introduce them into his field. At Dr. Elliott's suggestion, the situation was met by a system of seed certification by the State Plant Board, of which Dr. Elliott as Plant Pathologist was a member.

"Sweet potato certification, for which Dr. Elliott was in large part responsible, is based not only on sound pathological sense, but also on a sense of human nature. It provides for an inspection of sweet potato fields which, if they pass inspection, may be certified for seed. The inspection is entirely voluntary and is made only at the request of the seed growers. Compulsory inspection would have failed. Purchasers may then, if they choose, buy seed or slips that are free from disease. This plan of seed certification has been eminently successful in protecting the sweet potato industry of Arkansas, and has been copied by the Plant Boards of most of the Southern states.

"Dr. Elliott's most important investigative achievement from the point of view of prevention of economic loss, was in relation to the control of the boll rots by delinting cotton seed. Boll rots of cotton cause the South an annual loss of perhaps 10 per cent of the cotton crop. In a state like Arkansas in which the cotton crop means 40 per cent of the state's wealth, such a loss is no mean item. Nearly all the boll rots are either directly due to or are instigated by a cotton disease known as angular leaf-spot. The relation of this organism to boll rots was first established by Dr. Elliott. The ability required to solve this phase of the problem is clearly shown by the fact that for many years southern pathologists had failed in its solution. Delinting cotton seed, and thus destroying the organism carried on the lint, was first tried as a means of control in the laboratory and then on plantations in various parts of

the state on a larger scale. While it may be several years before the value of planting of delinted seed will be generally recognized by the cotton growers of the state, the financial returns to the cotton belt, due to this discovery, will amount to millions of dollars annually."

In the short period of six years, Dr. Elliott published a score or more of papers, including the following:

A study of the histological variations of *Quercus muhlenbergii*. Univ. of Kansas Sci Bull. **9**: 43–54. *Pl. 8–15.* 1914. Bibliography, p. 54.

An Alternaria on Sonchus. Bot. Gaz. **62**: 414–416. 1916.

The sweet potato "Soil Rot" or "Pox," a slime mold disease. Delaware Agric. Exp. Sta. Bull. 114. *25 p., 5 pl., 13 fig.* 1916.

Taxonomic characters of the genera Alternaria and Macrosporium. Amer. Jour. Bot. **4**: 439–476. *Pl. 19–20, 6 fig.* 1917. Literature cited, p. 474–475.

The conduction of potassium cyanide in plants. Phytopath. **7**: 443–448. *2 fig.* 1917.

Arkansas peach diseases. Arkansas Agric. Exp. Sta. Bull. 149. *9 p., 5 pl.* 1918.

Storage rots of sweet potatoes. Arkansas Agric. Exp. Sta. Bull. 144. *15 p., 4 pl.* 1918.

A smut on Iresine. Mycologia **2**: 87–88. *4 fig.* 1919.

A mosaic of sweet and red clovers. Phytopath. **11**: 146–148. 1921.

Arkansas cotton diseases. Arkansas Agric. Exp. Sta. Bull. 173. *26 p., 5 pl.* 1921. Literature cited, p. 15.

A new Ascochyta disease of cotton. Arkansas Agric. Exp. Sta. Bull. 178. *18 p., 4 pl., 1 fig.* 1922. Literature cited, p. 18.

Some characters of the southern tuckahoe. Mycologia **14**: 222–224. *Pl. 17–18.* 1922. Literature cited, p. 227.

The spread of tomato wilt by infected seed. Phytopath. **12**: 428–434. *Pl. 28, 2 fig.* 1922. Literature cited, p. 434. (Joint author with R. F. Crawford.)

His unpublished manuscript included several titles; two important ones of these are, "A Cytological Study of *Ceratostomella fimbriata* (E. & H.) Elliott." "The Breeding of Wilt Resistant Varieties of Tomatoes for Arkansas."

Dr. Elliott was a member of the American Association for Advancement of Science, American Botanical Society, American Phytopathological Society, American Society of College Professors; he was elected to the honorary society Sigma Xi.

OVERWINTERING OF TOBACCO WILDFIRE BACTERIA IN NEW ENGLAND

P. J. Anderson

One of the most baffling characteristics of the wildfire disease in the Connecticut Valley is its sudden and widespread recurrence every spring in the tobacco seed-beds. How do the bacteria from which the epiphytotic starts each year come into so many seed-beds? Where have they been during the six or eight months of winter, when everything is frozen up and there are no green leaves on which to live? Obviously the correct solution of this problem is of great importance to the pathologist who is seeking a better method of controlling wildfire. His first impulse is to say that the bacteria must be in the soil; but sterilization of the seed-bed soil is the rule with tobacco growers here and yet those who sterilize do not escape with much less infection than those who do not sterilize. In a previous publication (1:4)[1] Anderson and Chapman have presented sufficient reasons for believing that infected seed does not account for any large percentage of the trouble. Work on the overwintering problem was begun very soon after the disease appeared in Massachusetts, but although certain ways in which the organism might pass the winter were found, none of them seemed sufficient to account for a widespread simultaneous initial appearance of the disease such as we have experienced in the early spring for the last three years.

During the winter of 1922–23, the writer continued this investigation and believes that he has been able to add somewhat to our previous knowledge of the wintering problem. The experiments and his conclusions from them are presented in this paper.

EFFECT OF ALTERNATE FREEZING AND THAWING

In a previous publication (1:3) it has been shown that the bacteria are able to withstand considerable periods of freezing. But it is conceivable that alternate freezing and thawing might be more destructive. Neither was it proved in the previous experiments that they were still capable of producing infection after being frozen, when transferred to healthy plants. In order to determine these points, agar cultures were placed out doors in December and kept there during one of the most severe winters which New England has experienced in forty years.

[1] First number in parentheses refers to publication cited at close of this article; second number to page cited.

During the spring months they frequently thawed and were again frozen. At various times during the spring and summer of 1923 bouillon was poured into some of the tubes and in the majority of cases it clouded within a few days, indicating the multiplication of the bacteria. Typical lesions of wildfire were produced when tobacco plants were sprayed with these bouillon cultures. The last culture was tested and found to be still virulent after almost a year. The fact that the bouillon did not cloud in all cases indicates that a part of the bacteria were killed.

These results show that all the organisms are not killed nor rendered innocuous even during the most severe winter here. When, under certain conditions to be described below, they fail to survive the winter, it cannot be due merely to the unfavorable effect of freezing or of alternate freezing and thawing.

WINTERING IN THE CURING SHEDS

In May, 1923, diseased leaves were collected every week from the floor of a tobacco shed where they had been thrown when the tobacco was stripped during the winter. When these leaves were pulverized and dusted over wet growing tobacco plants the typical disease was developed at every test. Similar experiments conducted at different times by the writer (1:7) in Massachusetts and by Slagg and Chapman (1:7) and by Clinton and McCormick (2:417) in Connecticut invariably gave the same results. The ease and certainty with which virulent cultures have been taken from these cured leaves by every investigator proves that the bacteria must live over in great numbers and in virulent condition in the sheds. Such experimental data, strengthened by considerable observational evidence, incline the writer to believe that here is the principal source of the spring infection.

But after it has been demonstrated that the shed in which wildfire tobacco has been stored is full of potential contagion, the next step is to inquire how abundant are the opportunities for such infectious material to reach the seed beds or young plants in the field and thus start the spread of another year. Several ways in which this may be brought about have been mentioned in a previous publication (1:7). Additional observations have confirmed the suggestions made there and have uncovered other methods of accomplishing the transfer. In wildfire years it has been a common practice when the tobacco is stripped and put in the bundle to throw out the badly spotted leaves in order to avoid a cut in the price of the crop. The discarded leaves are either left on the floor of the shed or are carted out later. If left on the floor, they are

tramped over throughout the winter and spring and fragments of them carried on the shoes to all parts of the farm. Frequently wagons and tools are stored in the shed and on the wheels and tools, other fragments are carried out to the land. Even when the discarded leaves are carried away, broken parts are left on the shed floor and may be carried out in the same way. The carted-out leaves are usually thrown somewhere on the land. The chance of infection starting from these leaves thrown back on the land will be discussed presently. The minutest fragment of a leaf may be sufficient to start trouble in the beds. Such fragments may be blown by the wind from the loose sheds or from the loads of tobacco which are being carted away or from tools, etc. The same rake with which the discarded leaves are removed from the floor of the shed is often used in preparing the seed-bed. When one stops to consider the many possible ways in which the infected material from the shed may reach the new plants, one is not surprised at the abundant spring infection but wonders rather how any of the plants in the vicinity can escape. In several fields, the writer has observed field infection starting close to the tobacco shed, while the remainder of the field was clean. The inference from such cases is obvious. The tobacco shed undoubtedly furnishes the ideal winterquarters for *Bacterium tabacum*.

WINTERING IN LEAVES THROWN BACK ON THE LAND

It has just been stated that discarded spotted leaves are sometimes carted back onto the land. Such a case was investigated on a farm in South Amherst. After the owner stripped the tobacco in the late fall or early winter of 1922 he carted the refuse leaves out to land which he did not intend to use for tobacco. Here they remained all winter on the land—under the snow through a considerable part of the winter—but were not disintegrated by decay. On April 24, masses of them which were very badly weather-worn but on which the lesions were still visible were ground up and dusted on young plants. Wildfire lesions were apparent on these plants within ten days, thus demonstrating that the bacteria had survived under these conditions. Part of the material was placed back on the soil to be tested later. On the 31st day of May it was examined again and found to be pretty well rotted. Attempts to inoculate young plants with it were unsuccessful. Apparently the bacteria had died when the leaves rotted.

In the face of the positive evidence which we now have there could hardly be any doubt but that the bacteria survive the winter in such leaves which are not disintegrated. Being thrown out on the land, even

if it is not to be planted to tobacco, they could be blown easily to fields where tobacco is grown.

OVERWINTERING IN PLANTS LEFT STANDING IN THE FIELD

Occasionally badly diseased plants are not harvested but left standing in the field. Also, after the tobacco is harvested, suckers grow rapidly and if the fall is late may reach a height of two or three feet. In the wildfire years of 1921 and 1922 wildfire was extremely abundant on these suckers. In order to determine whether diseased plants like these which die and remain standing in the field through the winter might serve as a source of spring infection some badly diseased plants were left standing in a South Amherst field through the winter of 1922–23. On April 23 and on later dates up to May 25, some of the leaves from these plants were ground and dusted on to young plants. The results were positive in every test. Lesions developed on every inoculated plant. The leaves on these wintered plants were not disintegrated but remained dry and intact except that they were somewhat shredded and blown away by the wind. Under these conditions the organisms seem to be able to survive excellently. Such plants could very easily serve as centers of infection for the coming year.

WINTERING IN LEAVES BURIED IN THE SOIL

When tobacco leaves are buried, they disintegrate so rapidly that within a few weeks hardly a trace of them can be found. It was therefore found necessary to bury them between wire screens in order to be able to locate them when dug out again. In August, 1922, a quantity of very badly diseased leaves was buried in this way and left until May 7, 1923. When dug up, only small traces of leaves between the screens could be found but these traces and adhering soil were rubbed on wet punctured tobacco plants in the greenhouse. The same thing was repeated three times later up to June 13. None of the inoculated plants ever showed a trace of wildfire.

In a second experiment diseased leaves were chopped in a box of soil until the mixture was about 50 per cent leaves. This box of soil was then left outdoors all winter. Beginning on April 24, 1923, portions of this soil were rubbed on tobacco plants as in the preceding experiment but always with the same negative results. Tobacco seed was also planted in this soil on two different occasions. Only in one instance did any infection result and that one was late in the summer and there was good evidence that it came from a different source. Disregarding this

one case, all the other evidence indicates that the bacteria do not survive in these leaves which rot in the soil. Green leaves were also placed on top of the soil in September, 1922, with the intention of testing for the presence of bacteria in the spring of 1923 but they rotted so completely that no trace of them could be found in the spring.

WINTERING IN THE SOIL

We have presented abundant evidence (1:6) to show that the wildfire bacteria may exist for short periods in the soil and infect other plants from this source. But this does not mean necessarily that they are able to pass the winter in the soil. What little evidence we have on soil wintering is contradictory and not convincing. In the bulletin cited above we have presented the evidence on both sides and closed with the statement that the evidence is not convincing. Clinton and McCormick (2:376) correctly state that "we have very little convincing data along this line."

In Massachusetts Experiment Station Bulletin 213, p. 6, we have described an experiment in which the bacteria were kept in flasks of previously sterilized soil in pure culture from July, 1921, to March, 1922 and were still able to produce infection. In this experiment however the soil was not exposed to the weather but was kept in the laboratory and the soil was dry. Even in this experiment when the soil was kept too wet, they died before the expiration of the experiment.

In December, 1922, the above experiment was repeated but the flasks of soil kept outdoors during the winter. Some of this soil was placed on tobacco plants on April 23 and produced infection. The experiment was repeated on May 8, and on June 14. Infection resulted in every case, thus demonstrating that the bacteria can survive the winter when kept *in pure culture in previously sterilized soil.* But in nature they are not in pure culture. In order to more closely duplicate natural conditions, flasks of soil which had not been sterilized were inoculated and kept outdoors for the same length of time and under the same conditions as those previously mentioned. Inoculations were made at the same time as the above but no infection resulted in any case. The soil in these flasks was a little more moist (probably because of the drying effect of sterilization); otherwise the conditions were the same. This experiment leads one to suspect that the wildfire bacteria are killed by competition with other organisms.

In another experiment soil was collected from beneath the worst infected plants which could be found in the fall of 1922, kept over winter

outdoors and then rubbed on young plants in the spring. The inoculation was repeated a number of times but with consistent negative results. Seed was also planted in this soil but the plants never showed any infection.

In another experiment soil was taken from the base of the infected plants which were left standing in the field all winter in South Amherst. All attempts to inoculate with this soil resulted in failure.

In another experiment soil was taken from beneath the diseased leaves which had been thrown back in the field previously mentioned in South Amherst. No infection could be obtained from this soil.

The previously mentioned box of soil in which diseased leaves were chopped must have been teeming with bacteria but no infection in the spring resulted from rubbing this soil on wet punctured tobacco leaves.

Every attempt which the writer has made to get infection from unsterilized wintered soil has failed.

The fact that clean crops were grown on some fields during 1922 which had grown diseased crops in 1921 is in line with these data. The fact that in some fields wildfire has been observed in approximately the same location during successive years may be accounted for by sucker wintering or—in some cases at least—by proximity to tobacco sheds.

The evidence for soil wintering is so overwhelmingly negative that we are probably justified in concluding that in New England the wildfire bacteria do not winter in the soil or at most that this is a very minor source of spring infection.

WINTERING ON THE SASH AND SIDEBOARDS

Some evidence has been published previously (1:14) to show that the bacteria may remain alive on sash or on plank used for sideboards and thus become a source of infection in the spring. The evidence however is not conclusive. The following experiment was conducted during the winter of 1922–23 to determine whether the organism on dry wood such as the sideboards or sash may survive the winter and infect in the spring. In December, small blocks of pine wood were sterilized and then soaked in a pure culture of the bacteria. After a few hours, the blocks were removed from the cultures and kept in plugged test tubes outdoors all winter (an extremely severe winter). During April, May and June cultures were obtained from these blocks and the disease readily produced from these cultures. There are two ways in which the conditions in this experiment are different from those which might prevail on the farm. In the first place the bacteria were in pure culture, i. e., there were no other organisms on the wood. In the second place, the

blocks froze up before they were very dry and remained so until they thawed out in the spring. When however it is recalled that sash and plank may be stored under all gradations of moisture and that long desiccation (e. g., in leaves) does not kill the bacteria, it seems hardly likely that the conditions which were necessary for the experiment should influence the interpretation of the results.

All the evidence at hand from laboratory experimental data and from field observations too numerous to describe here indicates that sash and plank which have become contaminated by the growing of diseased beds or by being stored in or near sheds where diseased tobacco is stored may be regarded as sources of danger for the following crop.

WINTERING WITH THE SEED

In the South, the pathologists consider the seed as the principal carrier of bacteria from one season to the next. They therefore place especial emphasis on seed sterilization as a control measure. Reasons for believing that this is not an important source of spring infection in the Connecticut Valley are presented in a previous publication (1:4). In an effort to see whether a case of seed transmission could be found here, the seed plants in many fields were examined in the autumn of 1922. No infected pods were found except in one field in North Hadley. In this case the leaves of the plants were badly spotted and some lesions which were thought to be wildfire were on the pods. Such pods were gathered, dried and stored in a stoppered flask in the laboratory. In the spring they were threshed out and sprinkled over wet punctured leaves in the greenhouse but no infection resulted.

In a second experiment the pods of some plants in the greenhouse were punctured and inoculated from pure cultures during the autumn and abundant infection resulted. These pods were harvested and kept just as those previously mentioned. In the spring some of them were ground in a mortar and sprinkled on wet punctured leaves as above but with negative results. When however some of them were sowed, the resulting seedlings became infected while a plot of seedlings treated exactly like them but from disease-free seed, remained healthy. Here seems to be good evidence that if the bacteria are in the pods, they may live over and produce infection in the succeeding crop. There is no reason for believing that they would not live over in dry pods just as easily as in dry leaves. Pod infection has been seen so rarely in the Connecticut Valley tobacco section however and most growers are so careful not to save seed from diseased plants that the writer is not inclined to believe that this is an important source of spring infection.

SUMMARY OF WINTERING EXPERIMENTS

The writer's experiments and observations for the last three years seem to warrant the following conclusions as to the conditions under which the wildfire bacteria pass the winter:

1. They winter most successfully in situations where they are not subjected to keen competition from the growth of other organisms, principally in fairly dry situations; e. g., in cured leaves in the barn, leaves on plants standing in the field or thrown on the ground too late to rot, on boards, sash and dry fragments of pods.

2. They winter least successfully under conditions which are moist enough for the growth of competing organisms; e. g., in leaves in the ground or other situations where they decay, and in the soil.

PRACTICAL APPLICATION

In view of the conclusions just stated we may make the following recommendations to the grower:

1. If there has been wildfire in the field, plow under all leaves and stubble (before sowing the cover crop) as soon as the tobacco is removed. This will give all leaves and other harbingers of the pathogen an opportunity to become thoroughly decayed.

2. Do not leave diseased plants or suckers standing on the field during the winter.

3. Guard against the escape of infectious material from the barn where diseased tobacco has been hung. This is perhaps the most important source of spring infection.

4. If sash or plank have been stored in a barn where diseased tobacco is hung or if they have been used on an infected bed of the previous year, they should be sterilized.

5. If seed is saved from pods known to be free from disease, there is no advantage in sterilizing the seed.

6. If the above mentioned precautions are observed, there would seem to be no reason why a clean crop of tobacco cannot be grown on the same field which grew a diseased one during the previous year.

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DEPT. OF BOTANY,
MASS. AGR. EXP. STA.

HYPOXYLON POPLAR CANKER

ALFRED POVAH[1]

WITH ONE FIGURE IN THE TEXT

INTRODUCTION

There are but three canker diseases of poplars for which the pathogen is known, viz., bacterial canker caused by *Micrococcus populi* Del. (1), European canker caused by *Dothichiza populea* S. & B. (2), and Cytospora canker caused by *Cytospora chrysosperma* (Pers.) Fr. (3). The first two are indigenous to Europe and up to the present time only the second has been introduced into this country. The third disease is recorded only for the United States, being very common in the Southwest. It also occurs in New York State (4). The fungus grows commonly as a saprophyte on twigs and logs along the beach at Evanston, Illinois. It seems rather strange that the fungus is not parasitic in Europe where it has been known for a long time.

The subject of this article is a new canker disease of poplar which was found by Dr. L. H. Pennington in Essex County, New York. During the summer of 1920 field studies of the disease were made in the Town of Lewis, Essex County, New York.

DISTRIBUTION OF THE DISEASE

In Essex County, the poplars—*Populus tremuloides* Michx., *P. grandidentata* Michx. and *P. balsamifera* L.—are noticeably affected with this disease which eventually kills them. The mortality runs as high as twenty-seven percentage. Dr. Pennington has found this same canker disease in Oswego County, N. Y.

In October, 1920, this disease was found by the writer on *P. tremuloides* in a thicket near Pontiac, Oakland County, Michigan. This patch of woods was in low, wet ground and the principal species of trees and shrubs were: *P. tremuloides, Salix sp., Acer rubrum* L. and *Ilex verticillata* (L.) Gray. Approximately one half of the quaking aspens were infected and fifteen to twenty per cent killed.

Mr. J. Elton Lodewick, in a letter to the author from Orono, Maine, writes: "All along the west bank of the Penobscot River between Orono and Oldtown the canker is quite common—not so much so as in Lewis

[1] Grateful acknowledgment is hereby made by the writer to Dr. L. H. Pennington for suggesting the problem to him and for aid in various ways.

(N. Y.), but still common enough to be noticeable. *P. tremuloides* seems to be most infected, though it may only appear that way because that (*P. tremuloides*) is more abundant than *P. grandidentata*. *P. balsamifera* which grows mixed with trembling aspen along the river shows no cankers."

From the fact that we have the disease recorded from Maine, northern and central New York and Michigan, it seems quite probable that careful search will show that it occurs throughout the north-eastern part of the United States.

DATA ON SAMPLE PLOT IN ESSEX COUNTY, NEW YORK

In August, 1920, a survey of a sample plot in Lewis, Essex Co., N. Y., was made to determine the extent and importance of the disease. The area selected was chosen with regard to the amount of poplar rather than the prevalence of the disease. It is believed, therefore, that it represents the average condition in that region in a stand where poplar is dominant. The arborescent species in the plot, given approximately in the order of their abundance, were: *P. tremuloides*, *P. balsamifera*, *Pinus Strobus* L., *P. resinosa* Ait. and *Betula alba* var. *papyrifera* (Marsh.) Spach. A plot measuring one chain square was staked out and all the poplars in it were calipered. In determining the diameter breast high (D. B. H.) the usual practice was followed, i. e., the one inch diameter class includes all individuals up to and including those 1.5 inches in diameter; the two inch class, 1.6–2.5 inches in diameter, etc.

TABLE 1.—*Condition of Populus balsamifera in sample plot.*

Number of trees	D. B. H. in inches	Trees infected	Trees not infected	Killed by canker	Still living	Dead other causes
2	2	0	2	0	1	1
2	3	1	1	0	1	1
2	4	1	1	0	2	0
4	5	0	4	0	4	0
3	6	0	3	0	3	0
13		2	11	0	11	2

A glance at tables 1 and 2 will show that there were thirteen balsam poplars and ninety trembling aspens in the plot. We note also (table 1) that only two of the former were infected and neither of these were killed by the Hypoxylon canker. This is interesting in that it agrees with what Mr. Lodewick has observed in Maine. Of the quaking aspens,

however, 33 trees, or 37 per cent, were infected and 24 trees, or 27 per cent, were killed by the disease.

Table 2 shows that there is a correlation between age and susceptibility, i. e., the smaller the tree, the more susceptible it is to the disease. This is shown more graphically in table 3.

TABLE 2.—*Condition of Populus tremuloides in sample plot.*

Number of trees	D. B. H. in inches	Trees infected	Trees not infected	Killed by canker	Still living	Dead other causes
13	1	6	7	6	3	4
18	2	9	9	7	8	3
21	3	7	14	5	16	0
15	4	6	9	3	12	0
14	5	3	11	1	13	0
7	6	2	5	2	5	0
1	7	0	1	0	1	0
1	8	0	1	0	1	0
90		33	57	24	59	7

TABLE 3.—*Relation between age and infection.*

Percentage infected	Percentage killed	D. B. H. in inches
10.0	7.5	2
7.5	5.5	3
6.5	3.5	4
3.5	1.0	5
2.0	2.0	6
0.0	0.0	7
0.0	0.0	8

We can also note that susceptibility decreases as the tree grows older, so that if a tree is not infected before it reaches a diameter of seven inches it is relatively safe from infection. Probably this is to be explained by the increasing thickness of the periderm.

DESCRIPTION OF THE DISEASE

The disease is a trunk canker that occurs either low down or high up on the tree. In one instance measurement showed the lesion to be thirty feet from the ground. It is rather interesting to note that thus far cankers have been found on the bole only and not on the branches. Quite commonly infection results in the formation of an eccentric stem due to the killing of the infected region and the continued growth of the healthy portion of the trunk.

At first the diseased regions appear as small, slightly discolored, sunken areas which increase in size until they coalesce forming a canker, delimited by vertical cracks. On large trees, the lesion attains a length of several feet before girdling the trunk. In one tree studied, the canker extended for ten feet encircling the stem except for a strip one and one-half inches in width. Ultimately the disease kills the tree by girdling it.

As the canker develops, the diseased region takes on a grayish color in which occur black patches due to the superficial periderm flaking off

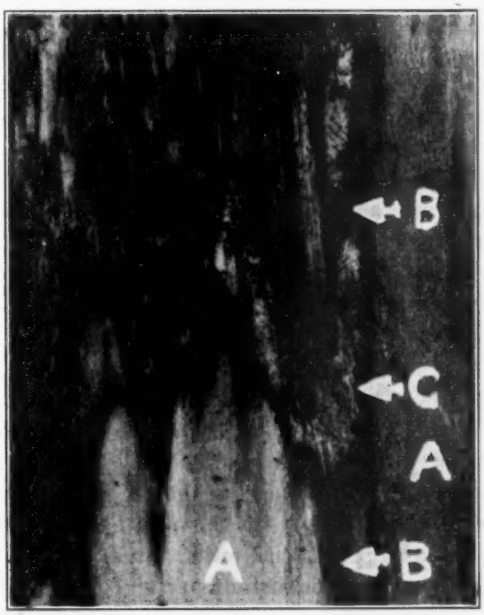

FIG. 1. Hypoxylon poplar canker after bark has been removed showing: A, normal wood; B, discoloration; C, mycelial fans.

and exposing the blackened cortex within. Scattered over the lesion are the stromata of *Hypoxylon pruinatum* (Klotsche) Cke.[1]

A transverse section of the diseased bark shows it to be composed of wide bands of a black, soft substance alternating with narrow, light-colored firm bands. The former are layers of cortex filled with the dark-brown hyphae of the fungus. The pale bands are layers of periderm which is not attacked because of its suberized walls. When the bark is peeled from a canker, the limits of the diseased area are shown

[1] Material was submitted to Dr. C. L. Shear who confirmed the author's identification.

by a blackening of the sap wood. The margin of this discoloration is irregular and vertically elongated in attenuated points between which are fans of whitish mycelium, resembling somewhat those of the chestnut bark disease, but differing in color.

Figure 1 shows the discolored wood and the fans of white mycelium on the sapwood of *P. grandidentata* after the bark has been removed.

DISCUSSION

The following synonymy of the fungus is given by Ellis and Everhart (5).

Sphaeria pruinata Klotsch.
Rosellinia pruinata Sacc.
Hypoxylon Holwayii Ell.
Hypoxylon pruinatum Cke.

According to these authors, *H. Holwayii* differs from *H. pruinatum* in that "surrounding the stroma and standing out obliquely like a coarse fringe, are short, coarse, black, bristle-like teeth, like the teeth of a Hydnum or Irpex. This curious growth also arises from the surface of the inner bark for some distance around the stroma, soon throwing off the epidermis and leaving the blackened surface of the inner bark exposed."

In our specimens the bristly appearance is found commonly but not constantly. In some cases it is due to the presence of small perithecia protruding from the inner bark in which they are formed, little or no stroma being present. Sometimes the same spine-like appearance is obtained by the breaking down of the perithecia leaving the jagged remnants of stroma and perithecial walls. In still other cases the dark teeth proved to be the more persistent parts of the inner bark left projecting after the softer part has been decayed.

It seems logical, therefore, to follow Ellis and Everhart in considering *H. Holwayii* as a synonym of *H. pruinatum*. Accordingly we have the range of the disease extended as the type material of *H. Holwayii* was collected in Iowa.

It is hard to account for the fact that this disease, which is common and striking in appearance has passed unnoticed up to the present time. Hartley and Hahn (6) in their paper on aspen diseases note three types of cankers. Type II might well be the Hypoxylon canker rather than of bacterial origin as these authors suggest. In figure 3 in their article, the broken tree shows plainly the mottled appearance so characteristic of the Hypoxylon Disease.

SUMMARY

A new canker disease of poplars has been found in New York and Michigan, and has been reported to the writer from Maine.

The pathogen is *Hypoxylon pruinatum* (Klotsche) Cke.

A field study in Essex County, New York, showed that over 36 per cent of the trembling aspens were infected and over 26 per cent killed by the disease.

Younger trees are more susceptible than older ones. No infections were found on trees larger than six inches in diameter.

The disease is a trunk canker and ultimately kills the trees by girdling them.

The lesion is manifest by slight discoloration of the bark and delimited by vertical cracks.

The sapwood is blackened, the discoloration extending vertically in attenuated points. On the darkened area are fans of whitish mycelium.

DEPARTMENT OF BOTANY,
NORTHWESTERN UNIVERSITY,
EVANSTON, ILLINOIS.

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HERPETOMONAD FLAGELLATES IN THE LATEX OF MILKWEED IN MARYLAND

FRANCIS O. HOLMES[1]

WITH TEN FIGURES IN THE TEXT

In 1909 Lafont (2) discovered in the latex of *Euphorbia pilulifera* in Mauritius a flagellate approximately twenty microns in length to which he gave the name *Leptomonas Davidi*. Since then more than twenty species of Euphorbia, and a number of latex-bearing plants of other genera, have been observed by many different investigators to be similarly parasitized. The original organism and related species have been reported from various islands in the Indian Ocean, from Africa, southern Europe, South America and the West Indies. Up to the present time, however, these organisms have not been reported from any of the latex-bearing plants in the United States. During the autumn of 1923 a number of such species growing near Baltimore, Maryland, were examined to determine whether or not flagellates could be found in them. A single species proved positive.

On August 30, 1923, a colony of milkweed[2] was found in which the latex swarmed with small elongate flagellates. Their motion could be observed in fresh smears under a moderate magnification. With an oil immersion lens dividing forms were seen moving among the others. These stages of division and the large numbers of organisms present indicated that the latex furnished a very satisfactory medium for growth and multiplication. Some of the flagellates moved but slightly, others very vigorously. Occasionally the flagellum of an individual could be seen, but the bodies of neighboring organisms made it difficult to examine the structural details of a single specimen.

STAINED PREPARATIONS

Smears of the latex were prepared and stained with Wright's modification of Leishman's stain. The organisms then showed the characteristic structures of the genus Herpetomonas. Nucleus, parabasal body, cytoplasm and flagellum took the usual stain for such organisms:

[1] Joint contribution from the laboratories of the Boyce Thompson Institute for Plant Research and of the Department of Medical Zoology, School of Hygiene and Public Health, Johns Hopkins University.

[2] Probably *Asclepias syriaca* L.; the flower was not available at that season, so that an exact determination could not be made.

nucleus purplish red with black granules near the nuclear membrane; parabasal body black; cytoplasm light blue; flagellum pink with a bluish cast.

TABLE 1.—*Measurements of milkweed Herpetomonads.*

Average measurements of Herpetomonads from Plant No.	Length of body	Anterior end to parabasal body	Parabasal body to nucleus	Length of nucleus	Posterior end to posterior margin of nucleus
1	12.7 ± 0.2 μ	1.2 ± 0.0 μ	1.7 ± 0.1 μ	1.5 ± 0.0 μ	7.9 ± 0.2 μ
2	12.2 ± 0.5	1.4 ± 0.1	1.6 ± 0.1	1.9 ± 0.1	7.2 ± 0.4
3	12.8 ± 0.6	1.5 ± 0.0	1.8 ± 0.1	1.7 ± 0.1	7.8 ± 0.5
4	13.3 ± 0.4	1.5 ± 0.0	2.0 ± 0.2	2.1 ± 0.1	8.1 ± 0.3
5	13.9 ± 0.4	1.4 ± 0.1	1.4 ± 0.1	1.9 ± 0.1	9.1 ± 0.4
6	14.0 ± 0.6	1.8 ± 0.1	1.7 ± 0.1	2.1 ± 0.1	8.9 ± 0.6
7	14.2 ± 0.2	1.4 ± 0.1	1.8 ± 0.1	1.8 ± 0.1	9.4 ± 0.3
8	14.4 ± 0.4	1.7 ± 0.1	2.2 ± 0.1	2.0 ± 0.0	9.0 ± 0.6
9	15.3 ± 0.5	1.2 ± 0.1	1.5 ± 0.0	2.0 ± 0.1	10.7 ± 0.6
10	15.6 ± 0.2	1.5 ± 0.0	2.0 ± 0.1	1.7 ± 0.0	9.9 ± 0.2
Range	12.2 to 15.6 μ	1.2 to 1.8 μ	1.4 to 2.2 μ	1.5 to 2.1 μ	7.2 to 10.7 μ
Average for group of 100 individuals, ten from each plant:	13.8 microns	1.5 microns	1.8 microns	1.9 microns	8.8 microns

Extreme range of length of body 9 to 21 microns; most measurements fall between 12 and 16 microns.

TABLE 2.—*Measurements of milkweed and Euphorbia flagellates.* (*After França.*)

	Leptomonas Elmassiani from milkweed, *Araujia angustifolia* (Gris.)	*L. Davidi* from *Euphorbia pilulifera*	*L. Bordasi* from milkweed, *Morreira odorata* Linderburg
	Paraguay	Mauritius	Paraguay
Body length:	12–15 μ	16.5–19.5 μ	24–27 μ
Flagellum:	4.5–7.5	10.5–16	7.5–9
Parabasal body to anterior end:	1.5	1.5	2.2–3
Parabasal body to nucleus:	1.5	3	3
Nucleus length:	1.5	2–3	3
Nucleus to posterior end of body:	7.5–10.5	10.5–12	16.6–18

Measurements of one hundred individuals, ten from each of ten plants, are tabulated in table 1. The average length of the body was 13.8 microns, of the nucleus 1.9 microns; the distance from the anterior tip to the

parabasal body was 1.5 microns, from the parabasal body to the anterior margin of the nucleus 1.8 microns, and from the posterior margin of the nucleus to the posterior tip of the body 8.8 microns. The length of the flagellum was very variable. Sometimes it exceeded the length of the rest of the body (See figure 6), but more often it was rather short. Occasionally leishmania forms were observed.

Figures 1 to 6 show typical flagellates from smears of the latex of the milkweed. Several successive stages of division are included.

Sections were prepared of the tissue of the seed pod, where the herpetomonads were very numerous. The individuals were so crowded together in the latex tubes that they were difficult to study, but frequently at the edges of the section and elsewhere very favorable views of the organisms were obtained.

NOMENCLATURE

A similar species was found in 1916 by Migone (3) in Paraguay in the latex of *Araujia angustifolia* (Gris.), a common milkweed. He gave it the name *Leptomonas Elmassiani*. Later França (1) studied his material of this species and compared it with *L. Bordasi* and *L. Davidi*, both of which are larger in size. His measurements are shown in table 2.

The flagellate from the Baltimore milkweed corresponds very well in size and morphological characteristics with the measurements here given by França for *L. Elmassiani* Migone. This name should be written *Herpetomonas elmassiani* (Migone), for the genera *Leptomonas* and *Herpetomonas* were united in 1884 by Bütschli, the first reviser, under the name of *Herpetomonas*. Perhaps for the present the flagellate from the Baltimore milkweed may be considered to be *Herpetomonas elmassiani* (Migone), since morphologically and physiologically it seems indistinguishable from the species first observed in Paraguay by Migone.

SUSPECTED INSECT CARRIER

A red and black hemipterous insect, *Oncopeltus fasciatus* (Dall.) was found closely associated with the infected plants. It is suspected of being the insect carrier of the flagellates. Plants on which it was found were, with but a single doubtful exception, positive. It was moreover associated with the majority of the infected groups studied, at the time they were examined. Both adults and nymphs of this species contained at times in their intestinal tracts flagellates such as are represented in figures 7 to 10. It will be noted that these flagellates are larger and more variable in size than the organisms in the plant, but that they are very

similar in general appearance. Their short forms are well within the range of size of the plant form.

In the late summer when these flagellates were first found, the infected plants were decidedly yellower than the seedlings, or uninfected second year plants. The yellowing may have been due to the flagellosis, as the latex was modified from a smooth creamy fluid to a watery emulsion of organisms.

Since the flagellates were not found until the last of August, it was not possible to carry out suitable transmission experiments this season to determine the exact standing of *Oncopeltus fasciatus* (Dall.) as a carrier of the flagellate, nor to attempt mechanical transmission from infected to uninfected plants. No effort was made to grow the organism in pure culture or to study its life history in detail. My studies on the effect of *Herpetomonas elmassiani* (Migone) on the health of the host plant are also necessarily incomplete, but because of the general interest in the subject of protozoa in plants it seems desirable to report the discovery of these organisms in the United States at this time.

SUMMARY

A flagellate infection of milkweed (probably *Asclepias syriaca* L.) was discovered during the autumn of 1923 near Baltimore, Maryland. The flagellates correspond fairly closely to those properly known as *Herpetomonas elmassiani* (Migone), described in 1916 by Migone in Paraguay. So far as is known this is the first report of such organisms in the United States.

A red and black hemipterous insect, *Oncopeltus fasciatus* (Dall.) is suspected of carrying the flagellates from plant to plant.

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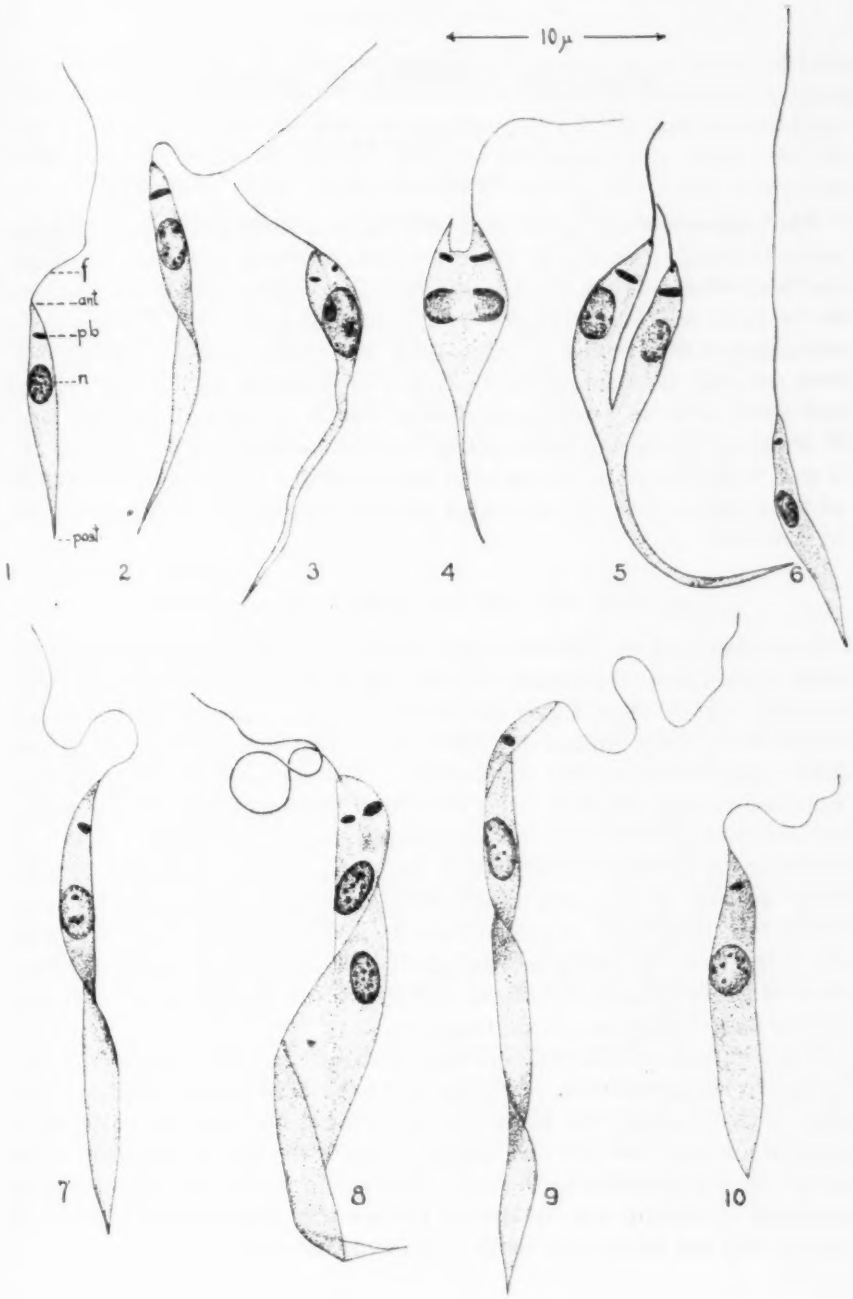
DESCRIPTION OF FIGURES

Figures 1–6. *Herpetomonas elmassiani* (Migone) from the latex of plants of a milkweed growing near Baltimore, Md. × 3000. *f.* flagellum, *ant.* anterior end of body, *p. b.* parabasal body, *n.* nucleus, *post.* posterior end of body. 1 and 2. Typical flagellates showing approximate position of organelles before division. The twist in the body of the second example is very characteristic. 3. Beginning of division. Parabasal body double. 4. Nucleus dividing. Cleft in cytoplasm. 5. Division of the organelles completed. Division of the body in progress. 6. A small individual with unusually long flagellum. Figures 7 to 10. Flagellates from the intestine of *Oncopeltus fasciatus* (Dall.). × 3000. 7. Flagellate of about average size, showing characteristic twist in the ribbon-like body. Except in its greater size it much resembles the flagellates from the latex of the milkweed. 8. Broad form in which division of the parabasal body and nucleus has already been completed. At this stage it is characteristic that one daughter nucleus should be farther from its parabasal body than the other. 9. A long form with more twists than it is usual to see among the plant flagellates in the latex smears. 10. A rather short individual, well within the length range of *Herpetomonas elmassiani* (Migone).



FLAGELLATES

BOTRYTIS CINEREA IN ALASKA

J. P. Anderson

With Plate III

The importance of *Botrytis cinerea* Pers. as a plant pathogen in Alaska seems to justify a somewhat more detailed statement as to its occurrence and host relations than was contained in the writer's earlier publications on the fungi and plant diseases (1, 2, 3) of that territory. Observations extending over a period of more than nine years, much of which has been spent in the practical cultivation of ornamental plants, truck crops, and small fruit in South-east Alaska, has convinced the writer that *B. cinerea* is by far the most serious fungous parasite in that region. It is well within the observed facts to state that more than three-fourths of all the fungous injury to cultivated plants in South-east Alaska is caused by Botrytis.

REASONS FOR THE PREVALENCE OF BOTRYTIS

The climate of the Pacific Coast region of Alaska is characterized by mild winters and cool summers accompanied by much cloudy and rainy weather. At Juneau, where the writer has spent most of the last seven years, the average annual precipitation is 76.5 inches, June being the driest month and October the wettest. The warmest month, July, has a normal average temperature of 57.9° F. The cool moist climate seems to be especially favorable for the development of Botrytis. While it occurs at all seasons and is liable to do damage during long spells of cool rainy weather, even in midsummer, it reaches its maximum development in the fall, the period of greatest precipitation. These observations of the writer as to the relation of temperature and moisture to the development of Botrytis agree with those of Stevens and Wilcox (4, 5) on strawberries and of Thomas (6) on tomatoes.

The influence of dampness is well illustrated by the behavior of the fungus in the greenhouse. During long periods of cloudy weather with little or no sunshine the air in the greenhouse becomes saturated with moisture, and if fires are not started so as to dry the atmosphere most of the plants will soon be ruined. The writer has found that the best methods of control are by drying the air and removing the parts of plants that are infected or liable to become infected.

METHOD OF INFECTION

The writer has never observed a single instance in which green vigorous leaf tissue has been directly infected by spores of *B. cinerea* even when spores were so numerous that thousands must have lodged on every leaf. Dying plant parts are readily infected as are mature fruits and the petals of flowers. Under very favorable conditions for the fungus the petals are often infected before the flowers open, causing the buds to decay.

After a vigorous mycelium has been developed on a flower petal or other susceptible plant part it spreads readily to healthy tissue with which it may come in contact. No species of flowering plant seems to be immune from its ravages, especially under greenhouse conditions. Even liverworts and mosses become infected where infected portions of flowering plants fall on them. Conidia develop rather sparingly on Bryophytes and Pteridophytes.

HOST RELATIONS

Among Spermatophytes, although no species is immune, there is considerable difference in susceptibility. Fruits of the blueberries (Vaccinium) are infrequently attacked, while the fruits of the salmonberry (*Rubus spectabilis*) are sure to become covered with the gray mold characteristic of Botrytis. The earlier ripening fruits may not be attacked for a week or two but conidia from the early fruits become abundant enough to attack the later fruit soon after ripening. It is interesting to note that as the fruit dries the Botrytis has a tendency to disappear and other fungi may develop, especially *Cladosporium herbarum* (Pers.) Lk. The fruit of the cultivated strawberry (*Fragaria sp.*) is very generally attacked by Botrytis species. Dr. N. E. Stevens of the Bureau of Plant Industry, has reported to the writer that during August, 1922, more than two-thirds of the decayed strawberries found by him in the fields at Haines and Sitka, and in the market at Juneau, contained Botrytis alone.

Although the writer has collected Botrytis on more than one hundred hosts he is convinced that a single species is common to all. This is shown by the fact that, whenever infected parts of one host species come in contact with a second host, infection of the second host by the fungus readily occurs. This cross-infection is very common and is illustrated in the accompanying plate.

GENERA OF PLANTS ON WHICH BOTRYTIS HAS BEEN COLLECTED IN ALASKA

These are all represented by specimens in the writer's collection at Juneau. Some of the genera are represented by more than one species.

Spermatophytes—Abutilon, Agave, Amelanchier, Amorphophallus, Antirrhinum, Apium, Artemisia, Asparagus, Begonia, Bellis, Brassica, Calceolaria, Calendula, Callistephus, Chamaenerion, Campanula, Cheiranthus, Chrysanthemum, Citrus, Coleus, Coreopsis, Cucumis, Cuphea, Dahlia, Dianthus, Dimorphotheca, Echinopanax, Erigeron, Eschscholtzia, Euphorbia, Fragaria, Fuchsia, Geranium, Gladiolus, Godetia, Grevillea, Grossularia, Helitropium, Hibiscus, Hippeastrum, Hosta (Funkia), Hydrangia, Iberis, Lactuca, Lantana, Lathyrus, Ligularia (Farfugium), Linaria, Lobelia, Lonicera, Lychnis, Lycopersicum, Matthiola, Melissa, Mimulus, Myrsiphyllum, Nepeta, Nicotiana, Oenothera, Oxalis, Papaver, Pelargonium, Phaseolus, Phlox, Pisum, Poa, Potentilla, Primula, Prunus, Rheum, Rhinanthus, Ribes, Rosa, Rubus, Sambucus, Senecio (Cineraria), Solanum, Tagetes, Thymus, Tradescantia, Tropaeolum, Tulipa, Vaccinium, Vicia, Viola, Zebrina, Zantedeschia (Calla), Zinnia.

Pteridophytes—Athyrium, Cyrtomium, Nephrolepis.

Bryophytes—Lunularia.

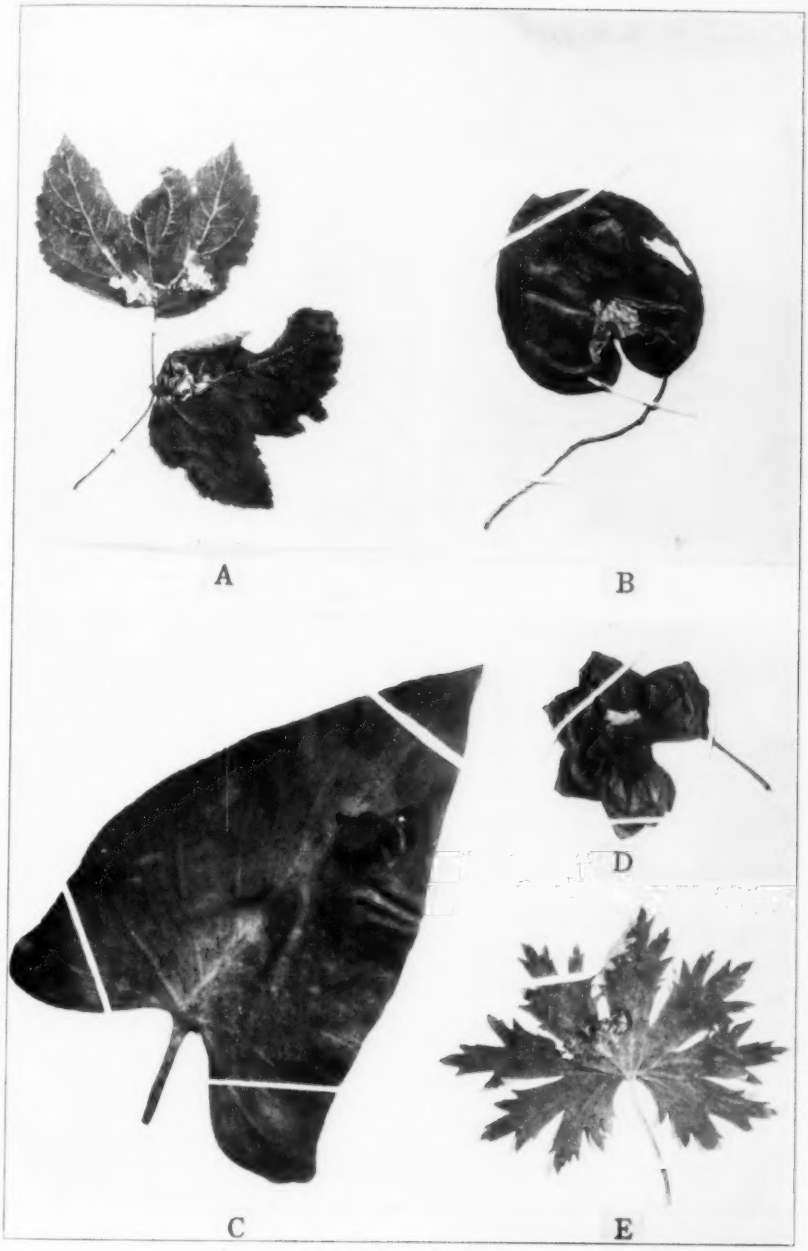
Botrytis cinerea Pers. is supposed to be the conidial stage of *Sclerotinia fuckeliana* (DeBy.) Fcl. but the writer has never found the ascigerous stage, and has found sclerotia only a few times. Several years ago sclerotia developed abundantly on some cabbage in a cellar. Some of these were brought into the greenhouse and later developed dense masses of conidia but no apothecia.

SUMMARY

The cool damp climate of the Pacific Coast region of Alaska is especially favorable for the development of *Botrytis cinerea*, which is much the most destructive fungus to living plants observed there.

Although generally considered a weak parasite and certainly not capable of infecting vigorous green leaf tissue by conidia, it grows readily into healthy tissue from previously infected weaker portions.

It attacks nearly all species of plants but there is a difference in susceptibility of various species. There seems to be but one common species in Alaska which passes readily from one host to another. The ascigerous stage is seldom or never formed in Alaska but sclerotia are sometimes found.



BOTRYTIS CINEREA ON VARIOUS HOSTS

UNIV. OF MICH.

It is more destructive to garden and greenhouse plants than to native species. Removing affected plants or parts of plants, together with drying the atmosphere, are the most efficient methods of control in the greenhouse.

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DESCRIPTION OF PLATE III

A. Leaf of *Rubus spectabilis* infected with *Botrytis cinerea* from fallen floral parts of *Epilobium angustifolium*, collected in September, 1922. B. Cyclamen infected from Fuchsia. C. Calla infected from *Pelargonium domesticum*. D. *Pelargonium peltatum* infected from *Senecio cruentus*. E. *Pelargonium domesticum* infected from *Begonia semperflorens*. B, C, D, and E are from artificial inoculations made by placing infected portions of plants on sound, healthy leaves of other species. All from photographs made by Winter and Pond Company.

THE RELATION OF TEMPERATURE AND HUMIDITY TO TOMATO LEAF SPOT (SEPTORIA LYCOPERSICI SPEG.)

FRED J. PRITCHARD AND W. S. PORTE

WITH PLATE IV AND NINE FIGURES IN THE TEXT

INTRODUCTION

As tomato leaf spot, or blight (Pl. IV), causes an average annual loss of approximately 250,000 tons in the yield, and corresponding reductions in the quality, of commercial tomatoes in the United States, the relation of temperature, humidity, or any other factor, to its development and control is both interesting and important to the tomato grower and the manufacturer of tomato products. The present paper is confined to a discussion of the temperature relations of the parasite and host, and the temperature and humidity relations of the disease, with suggestions for leaf spot control based on temperature relations of the parasite.

Tomato leaf spot is quite widely distributed east of the Rocky Mountains and is common and destructive in the Middle Atlantic and Middle Western States, but is apparently absent in the Pacific Coast region. Its distribution has usually been assumed to be conditioned by atmospheric humidity. In fact, we know from the inoculation of more than a hundred thousand tomato plants in our selection experiments for resistance to leaf spot that the number of infections always increases with the relative humidity of the air. However, the fact that leaf spot is absent on the Pacific Coast and is only sparingly present in the North Atlantic and Gulf States, where the relative humidity is very high, would indicate that temperature or some other factor plays an important part in its distribution. We have therefore investigated the temperature relations of the leaf spot fungus (*Septoria lycopersici*) in order to determine to what extent they affect its development and in what way, if any, they may be made use of in the application of control measures.

MATERIAL AND METHODS

The temperature relations of the fungus in culture were determined by means of a Paul Altmann's Incubator. This apparatus consists of 20 chambers, each provided with a pan of water for maintaining high humidity and a thermometer for reading the temperatures. A circulating water system in which the water is heated by electric coils controlled by thermostats at one end of the series and cooled by ice at the other is used

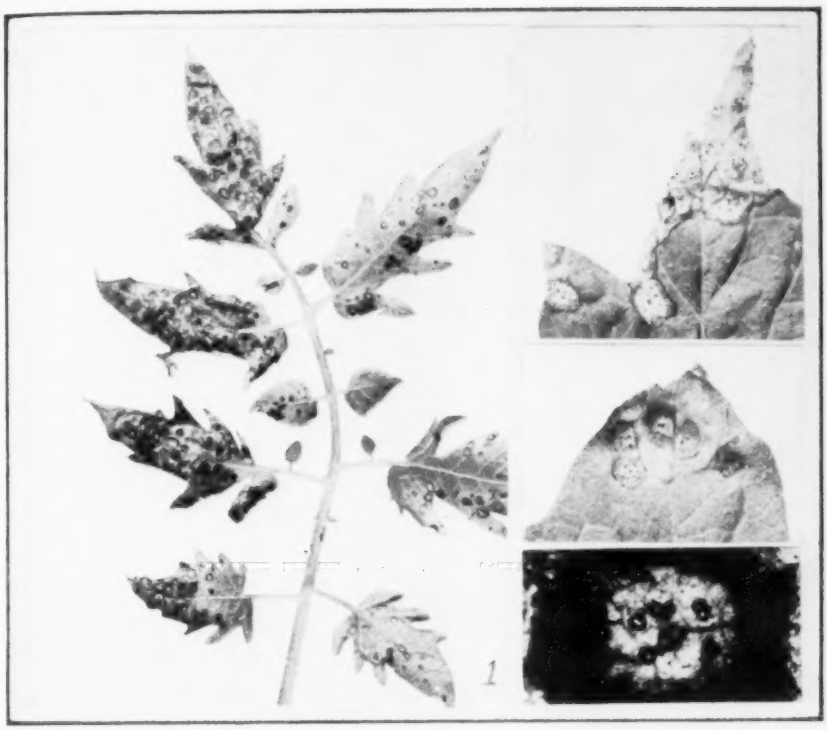

PLATE 1, FIG. 1. Septoria leaf spot on tomato leaves. Spots on leaf at left about natural size; spots at right enlarged to show pycnidia (spore pustules).

PLATE 1, FIG. 2. Effect of Septoria leaf spot on tomato crop. Plants in field at left nearly destroyed by leaf spot; those in field at right healthy.

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to keep the chambers at different relatively constant temperatures. The apparatus was kept in an insulated room cooled to about 22° C. by means of ice. The temperature of each chamber remained fairly constant during the experiments, usually varying less than 1° C., but the difference between the temperatures of adjoining chambers varied from 1° to 5° and averaged approximately 2°.

The temperatures were read daily and averaged for each chamber. The experiments on the optima and maxima were run from 2 days to 2 weeks, depending on the rapidity of growth, those on the minima, one month. The average temperatures obtained by this method are therefore only approximately correct but are accurate enough for most practical purposes.

The culture media used in the experiments on growth temperatures were cornmeal and cornmeal agar; in the experiments on sporulation temperatures, fairly dry cornmeal.

TEMPERATURE RELATIONS OF SEPTORIA LYCOPERSICI IN CULTURE

The following growth temperatures were obtained for *Septoria lycopersici* in culture: minimum 35°, optimum 77°, and maximum 94° F. In flask cultures the lowest temperature at which growth was visible by means of the unaided eye was 42.8° but in hanging drops it was discernible by means of the microscope at 35°. As scarcely any growth was obtained at approximately 43° F. in a month's time, very little growth would be made by this fungus outdoors in the spring of the year below 45°. Although the fungus grew best at 77°, it grew well between 54° and 82°.

There was considerable difference between the range of temperature for growth and the range for sporulation. Although the optimum for the latter was the same as for growth, viz. 77°, the minimum was 59° and the maximum 80.5°. The relation of these sporulation temperatures to the development and distribution of leaf spot and to means for its control will be discussed in another part of this paper.

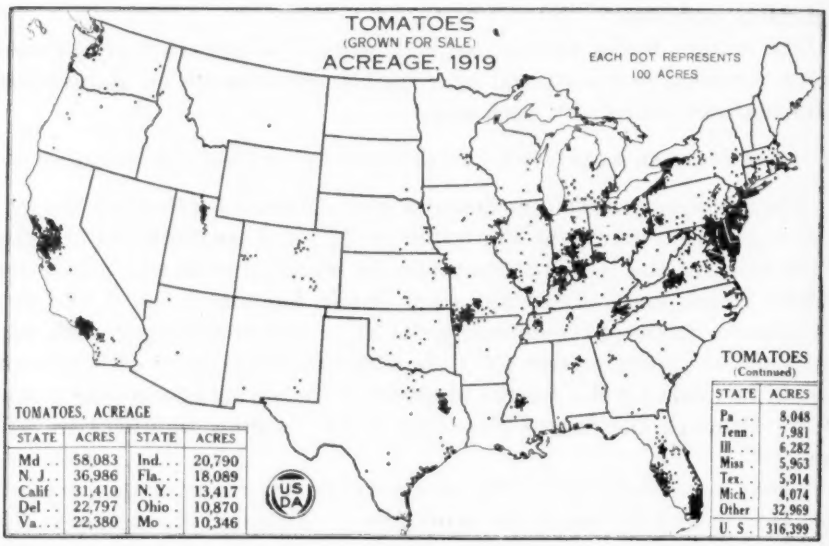
TEMPERATURE RELATIONS OF THE HOST

The optimum range of temperatures for the growth of tomato plants determined by Clayton[1] (2) is 77° to 86° F. Although these temperatures apparently give the best vine growth, they are higher than are commonly

[1] The temperatures determined by Clayton were soil temperatures but the average temperatures of the first few inches of soil do not differ materially from the temperatures of the air for the same locality.

used for growing tomatoes under glass. It would therefore seem that lower temperatures are more favorable for the production of fruit.

The optimum temperature for the production of tomato fruit can be determined approximately, at least, from statements of experienced gardeners and from weather bureau and field records on temperatures and yields. For greenhouse crops of tomatoes, Iggulden (4) recommends a temperature of 50° to 55° by night and 60° to 65° by day; Greene (3) 60° at night and 70° or 75° during the day. About 60° F. is also recommended by the "Fruit, Flower, and Vegetable Trades' Journal." (1) These temperatures are somewhat lower than preferred by Watts (6), viz.



TOMATOES, ACREAGE

STATE	ACRES	STATE	ACRES
Md . .	58,083	Ind. . .	20,790
N. J. .	36,986	Fla. . .	18,089
Calif .	31,410	N. Y. .	13,417
Del . .	22,797	Ohio .	10,870
Va. . .	22,380	Mo . .	10,346

TOMATOES
(Continued)

STATE	ACRES
Pa . .	8,048
Tenn .	7,981
Ill. . .	6,282
Miss .	5,963
Tex. .	5,914
Mich .	4,074
Other	32,969
U. S .	316,399

FIG. 1. Areas of tomato production for commercial purposes.

80° to 90° during the day and 15° to 20° lower at night, but approximately the same as recommended by Mayer.[1] Mayer, who is in charge of the (U. S. Government) Experimental Greenhouses at Arlington, Virginia, has had much experience in growing tomatoes at a considerable range of temperatures and is very skillful in growing tomatoes and other crops under glass. His recommendation of 60° to 65° at night and 65° to 70° in the daytime as the best for forcing tomatoes is probably not far from the optimum.

[1] This recommendation by August Mayer was given to the writers verbally.

TABLE 1—*Relation of temperature to yield of tomatoes.*

State	Average yield, tons per acre from 1918 to 1921	Average daily temperature F. during growing season	Average length of growing season	Average date of last killing frost in spring	Mean monthly temperature in the principal tomato canning regions of each state†								Average date of first killing frost in autumn
					Apr. °F.	May °F.	June °F.	July °F.	Aug. °F.	Sept. °F.	Oct. °F.	Nov. °F.	
Utah	10.0	65	5/20-10/5	4/23	45	55	65	70	70	60	50	35	10/18
Colorado	7.4	65	5/25- 9/25	4/28	46	55	60	70	70	60	50	36	10/5
Washington	7.1	57	5/1 -11/1	3/21	45	55	56	60	63	55	50	41	11/22
New York	7.1	65	5/20-10/5	5/3	45	55	65	70	68	62	51	39	10/20
Oregon	6.9	59	4/20-11/1	3/17	50	55	60	65	65	60	50	45	11/16
California	5.9	62	4/1 -11/1	4/8* 2/16**	55	60	65	66	66	62	60	52	11/15
Ohio	5.3	69	5/20-10/5	4/20	50	61	68	74	71	65	53	42	10/15
Idaho	5.2	64	4/25- 9/25	3/23	50	55	65	70	70	60	50	40	10/5
Connecticut	4.8	66	5/15-10/10	4/15	45	57	66	71	69	63	51	41	10/25
Michigan	4.8	67	6/1 -10/5	5/1	46	57	66	71	70	63	51	39	10/14
Massachusetts	4.7	65	5/20-10/5	4/22	45	56	65	70	67	61	49	40	10/20
New Jersey	4.4	69	5/10-10/15	4/10	50	60	70	74	73	67	57	44	11/1
Indiana	4.2	72	5/10-10/1	4/10	53	64	72	76	75	68	55	44	10/17
Illinois	4.2	71	5/15-10/1	4/15	51	62	71	76	75	68	55	40	10/15
Pennsylvania	4.1	67	5/20-10/10	4/22	49	60	66	74	70	65	54	40	10/25
Minnesota	4.0	66	6/1 - 9/25	5/7	45	56	66	71	67	60	47	32	10/5
Iowa	3.7	70	5/20-10/1	4/22	50	59	70	75	74	65	53	38	10/12
Kansas	3.7	74	5/15-10/1	4/15	55	65	73	78	78	70	57	42	10/15
Oklahoma	3.7	75	5/5 -10/20	4/5	60	67	76	81	81	74	62	50	11/1
North Carolina	3.6	73	5/10-10/20	4/8	58	68	75	78	77	71	60	50	11/1
Delaware	3.4	69	5/5 -10/20	4/6	52	62	71	75	74	68	58	45	11/1
Louisiana	3.4	74	2/25-11/15	1/24	68	75	82	82	82	79	70	60	12/1

TABLE I—*Continued.*

State	Average yield, tons per acre from 1918 to 1921	Average daily temperature F. during growing season	Average length of growing season	Average date of last killing frost in spring	Mean monthly temperature in the principal tomato canning regions of each state†								Average date of first killing frost in autumn
					Apr. °F.	May °F.	June °F.	July °F.	Aug. °F.	Sept. °F.	Oct. °F.	Nov. °F.	
Maryland	3.4	70	5/5 –10/20	4/8	53	63	72	76	75	69	57	46	11/1
Mississippi	3.4	75	4/5 –10/25	3/6	66	73	80	81	81	76	65	55	11/7
Tennessee	3.3	73	5/5 –10/10	4/5	58	68	75	78	76	70	60	49	10/22
West Virginia	3.3	68	5/20–10/10	4/20	51	61	70	73	71	65	55	40	10/23
Wisconsin	3.3	66	6/1 –10/1	5/10	43	54	65	71	68	60	48	35	10/8
Virginia	3.2	72	5/15–10/15	4/15	56	66	74	78	77	69	58	47	11/2
Nebraska	3.0	72	5/20– 9/20	4/21	52	61	71	76	75	66	54	38	10/1
Texas	3.0	75	4/5 –11/1	3/5	65	72	80	82	82	77	66	57	11/13
Alabama	2.9	75	5/1 –10/20	4/1	62	70	77	80	79	74	62	52	11/1
Kentucky	2.9	72	5/5 –10/5	4/6	56	66	74	77	76	70	57	46	10/21
Arkansas	2.8	73	5/5 –10/15	4/5	59	66	75	80	79	70	60	49	10/28
Georgia	2.7	74	4/25–10/25	3/25	60	70	78	80	78	73	62	51	11/5
South Carolina	2.7	74	4/10–11/5	3/10	64	73	77	82	80	76	65	55	11/15
Missouri	2.6	73	5/5 –10/15	4/8	57	65	74	79	78	70	59	47	10/25
New Mexico	2.6	75	5/5 –10/5	4/5	60	70	76	80	80	71	60	50	10/15

† The data for Florida is omitted because it can not be put into this table but its omission does not alter the results.
* Los Angeles.
** Sacramento.

The optimum temperature for the production of field crops of tomatoes has been determined from the average monthly temperatures of the tomato areas of each state (Mo. Wea. Rev. V. 49, No. 11, 1921 and Year Book of the U. S. D. A. 1921, p. 462) as shown in figs. 1–7. The average length of the growing season was estimated from the average dates of the last killing frost in the spring and the first killing frost in the autumn (Climatology of the U. S. Bull. Q, plates 19 and 20) and the average yields of tomatoes per acre (1918–1921) were calculated from the data in Wea. Crops and Markets, V. 1, No. 6, Feb. 1922, p. 116. These results are summarized in table 1.

As shown by the above table, the average daily temperature during the growing season varied from 57° in the State of Washington to 75° in Oklahoma, Mississippi, Texas, Alabama and New Mexico. The average daily temperature of all these localities is approximately 69° F. but even the highest daily temperature, viz. 75°, is lower than the optimum range for vine growth (77°–86°) found by Clayton (2).

With one exception, viz. Ohio, all the average yields of 5 tons or more per acre were obtained where the average daily temperature during the growing season was 65° or less. There are a few cases of low temperatures where relatively low yields were obtained, viz. Minnesota, Wisconsin, and West Virginia, but in at least two of these states yields are often reduced by frosts. Pertinent at this point is the following quotation from Climatology of the United States, Bulletin Q, p. 33: "Light frost during the latter part of August is not an unusual occurrence over Michigan, Wisconsin, Minnesota, the Dakotas, and Montana." In fact, the coldest September of record for Wisconsin was in 1918 (a year of this yield period) and the yield of tomatoes for the state averaged only 0.9 tons per acre.

In correlation table 1 made from the above data the relation of temperature to yield can be seen more clearly:

In table 2, a high inverse correlation exists between yield of tomatoes per acre and average daily temperature during the growing season. Owing to the wide area on which these tomatoes were grown, however, and the differences in soil fertility, soil moisture, and climatic factors other than temperature, it is uncertain how much of this correlation is due to the effect of temperature on yield and how much to some other factor, particularly soil fertility, incidentally correlated with temperature. For this reason the coefficient of correlation was not calculated. However, it would seem that temperature rather than soil fertility is the predominating cause of this correlation, since only medium to low yields

were obtained on the rich soils of Illinois, Iowa, Kansas, and Nebraska, where medium high temperatures prevail. Moreover, in regions where the fertility of the soil is low fertilizer is usually added to make up the shortage. This would tend to overcome the effects that would otherwise arise from differences in soil fertility.

As shown by table 2, the highest yields were obtained at or below 65° and the lowest at or above 72°. Moreover, it would appear from this table that 65° is the optimum temperature for the production of tomatoes.

TABLE 2—*Correlation between yield of tomatoes per acre and average daily temperature during the growing season.*

Yield per acre	Average daily temperature																	
tons	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
2.5–2.9																1	2	2	2
3.0–3.4										1		1	1	1		1	1	2	2
3.5–3.9														1			1	1	1
4.0–4.4										1	1		1		1	1			
4.5–4.9									1	1	1								
5.0–5.4								1					1						
5.5–5.9						1													
6.0–6.4																			
6.5–6.9			1																
7.0–7.4	1								2										
7.5–7.9																			
8.0–8.4																			
8.5–8.9																			
9.0–9.4																			
9.5–9.9																			
10.0–10.4									1										

It is not surprising that the optimum temperature for vine growth is different from that for yield of fruit, for excess vine growth usually results in the development of very little pollen and a poor set of fruit. As is commonly known, a good set of fruit is quite as essential as favorable growth factors for the production of high yields.

RELATION OF TEMPERATURE TO THE DEVELOPMENT OF THE DISEASE

It was shown by Pritchard and Porte (5) that in tomato plants susceptibility to leaf spot is correlated with rapidity of growth. Although differences in rapidity of growth in these experiments were caused by different kinds and quantities of fertilizer, susceptibility to leaf spot was independent of the kind or quantity of fertilizer used except as it

affected growth. Within certain limits therefore it is quite likely that rapid growth induced by temperature would have a similar relation toward leaf spot. Since the optimum range of temperatures for the growth of the tomato plant is 77° to 86° and the optimum range for the growth of the fungus 54° to 82°, the optimum for the disease would apparently occur where these ranges overlap.

RELATION OF TEMPERATURE TO THE DISTRIBUTION OF LEAF SPOT

It is evident from an examination of fig. 5 that the percentage losses from tomato leaf spot are heaviest in the Middle Atlantic and Middle Western States. Within this area leaf spot reaches its maximum development in the states bordering the Atlantic Coast and decreases gradually westward. It is of very little importance in the northern and southern tiers of states and is apparently absent in the Pacific Coast region.

Within the Middle Atlantic and Middle Western States leaf spot develops most rapidly in July, August, and the fore part of September. The chief development occurs in a temperature belt of 73° to 78° F. (figs. 4–5). This probably explains why leaf spot does not appear in the tomato regions beyond the Rocky Mountains as the temperatures are too low. It also explains why it is relatively unimportant in New York, Michigan, Wisconsin, Minnesota, and the Dakotas. The temperature conditions in the Gulf States would seem to inhibit the development of pycnidia and spores of *Septoria lycopersici* in the fields before June, unless the plants were infected in hot beds, cold frames, or other sheltered places. Although the mean monthly temperature for April in central Georgia, Alabama, Mississippi, and Texas is 65°, pycnidia and spore development would take place very slowly at this temperature, which is little above its minimum, viz. 59° F. In May the mean monthly temperature for this area is more favorable, viz. 73° (fig. 2), but in June it is approximately 80° (fig. 3), while the maximum temperature for sporulation is 80.5°. In July and August (figs. 4–5) the temperature is still higher in these states. Because of these cool spring and high summer temperatures the leaf spot fungus has little opportunity to sporulate and spread. In September (fig. 6) the mean monthly temperature for this area is 75° but in October it is only 65° F. (fig. 7). Hence the failure of *Septoria lycopersici* to cause much damage in the Gulf States is apparently due to the shortness of favorable periods of temperature for the successful development of pycnidia and spores.

RELATION OF RELATIVE HUMIDITY TO THE DISTRIBUTION OF LEAF SPOT

A belt of uniformly high relative humidity along the coasts of the United States averages about 75 to 80 per cent at all seasons of the year. A somewhat similar amount occurs in the Great Lakes region. From the Great Plains eastward to the Atlantic Coast the amount varies between 70 and 75 per cent without much seasonal variation.

It is obvious from an examination of the humidity charts for July (figs. 8–9),[1] which also show percentage losses from leaf spot,[2] that New Jersey, Delaware, Maryland, and Virginia have a higher relative humidity than states farther west in the same temperature belt; also that North Carolina, Kentucky, and Tennessee have a higher relative humidity than Illinois, Iowa, Missouri, and Kansas. These relative humidities are correlated with leaf spot losses. Septoria leaf spot therefore develops best in a very moist atmosphere but its distribution, as shown by its absence on the Pacific Coast and only sparse presence along the Gulf of Mexico and North Atlantic Coast, is conditioned more by temperature than by humidity.

EFFECT OF TEMPERATURE ON THE CONTROL OF LEAF SPOT

Since the high minimum sporulation temperature (59° F.) of *Septoria lycopersici* greatly retards its development in the spring, the growing of earlier crops of tomatoes offers at least a partial means of escaping it. Some of the large companies manufacturing tomato products have already begun the growing of earlier crops by the use of southern-grown plants. Although the use of such plants is attended with the danger of introducing other diseases, especially wilt, it insures an earlier start for the crop, a shorter period of leaf spot attack, and a cooler temperature in the early part of the season when the first blossoms form. Cool temperatures appear to check vegetative growth and induce fruiting. Fruit set in the first cluster also checks vine growth. Hence this practice of using southern-grown plants seems sound, but if sufficient precautions are not taken it may result in bringing in plants infected by leaf spot and early blight, which would cause an earlier outbreak of these diseases.

The protection of the late crops of tomatoes from leaf spot would seem to depend on measures for preventing the overwintering of the fungus. Because of the retarding effect of spring temperatures on the sporulation of *Septoria lycopersici*, leaf spot does not usually appear on tomatoes

[1] From Mo. Wea. Rev. 50: 575–581. 1922.

[2] Calculated from Plant Disease Survey Records (Plant Disease Bulletins).

in the field in the Middle Atlantic and Middle Western States before the middle or latter part of June. Effective measures for preventing its overwintering would greatly reduce the number of early infections in the field and retard its spreading. Thoroughly plowing under all the old tomato vines in the fall or early spring and planting the land to a non-cultivated crop without bringing any of the vines to the surface while preparing the seed bed will destroy the leaf spot fungus on them. Experimental data, which will be published later, show that this fungus can not live in the soil.

As the leaf spot fungus also infects potatoes, eggplants, horse nettle, Jimson weed, and a number of other wild Solanums and probably other weeds, all of these hosts should be kept off tomato land, as otherwise the fungus would overwinter on them.

The avoidance of tomato seedlings grown in hot beds, cold frames, or other sheltered places infested by Septoria or brought from unknown sources also helps to prevent the spread of the disease. In fact, the seed bed, because of its sunny location, well manured soil, and protection from winds, is warmer than the exposed fields and consequently is often the source of early infections, although the disease may not be apparent when the plants are set out.

Because of the temperature limitations on the production of spores and the consequent late appearance of the disease in the fields, except when carried there from the seed bed, such means as outlined for preventing the development and spread of leaf spot can be made effective without much expense.

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(6) WATTS, RALPH L. Vegetable gardening, *p. 452*.

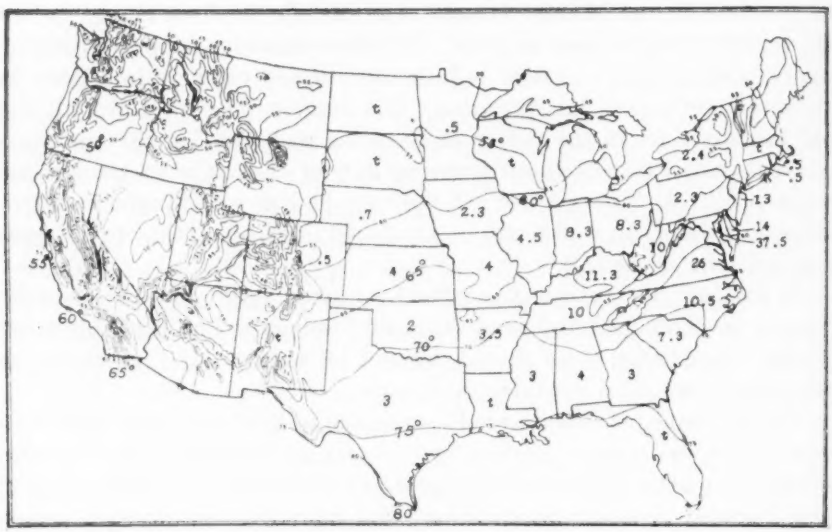

FIG. 2. Average monthly temperature for May and percentage of tomato crop destroyed by leaf spot (*Septoria lycopersici*) from 1918 to 1921.

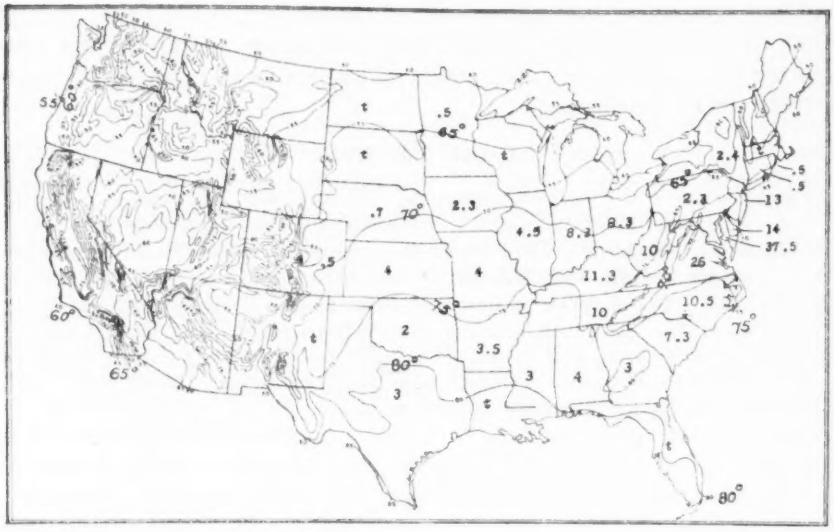

FIG. 3. Average monthly temperature for June and percentage of tomato crop destroyed by leaf spot (*Septoria lycopersici*) from 1918 to 1921.

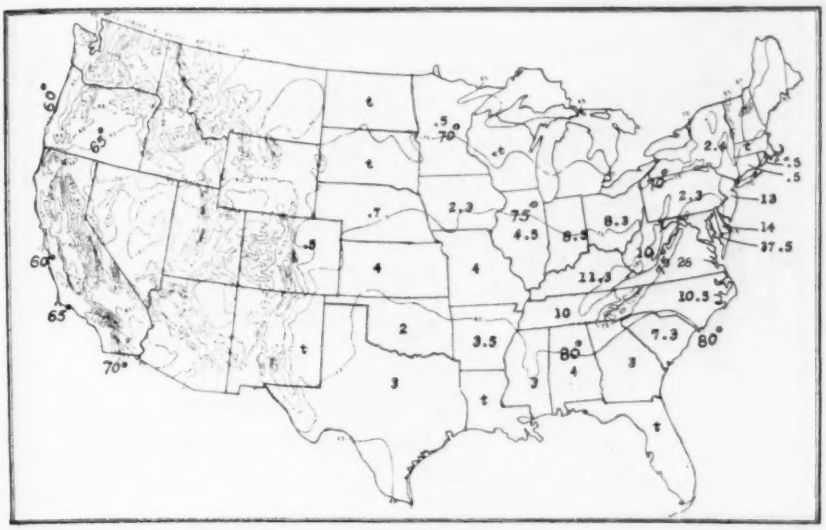

FIG. 4. Average monthly temperature for July and percentage of tomato crop destroyed by leaf spot (*Septoria lycopersici*) from 1918 to 1921.

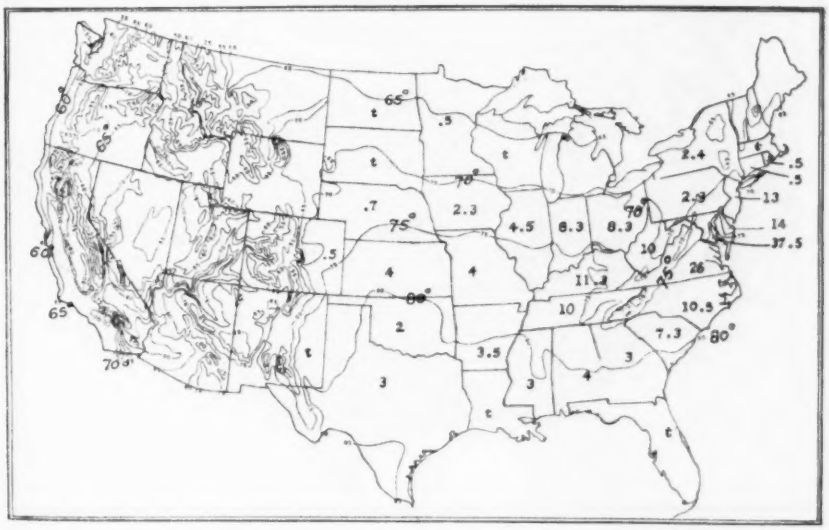

FIG. 5. Average monthly temperature for August and percentage of tomato crop destroyed by leaf spot (*Septoria lycopersici*) from 1918 to 1921.

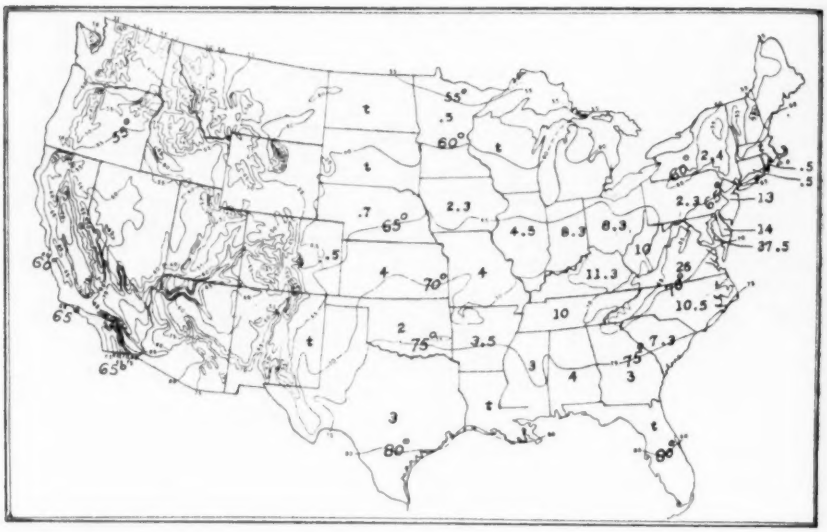

FIG. 6. Average monthly temperature for September and percentage of tomato crop destroyed by leaf spot (*Septoria lycopersici*) from 1918 to 1921.

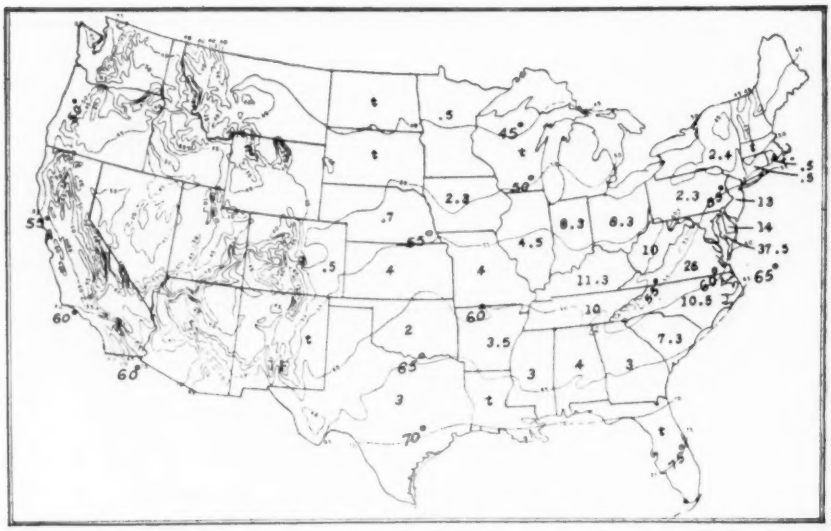

FIG. 7. Average monthly temperature for October and percentage of tomato crop destroyed by leaf spot (*Septoria lycopersici*) from 1918 to 1921.

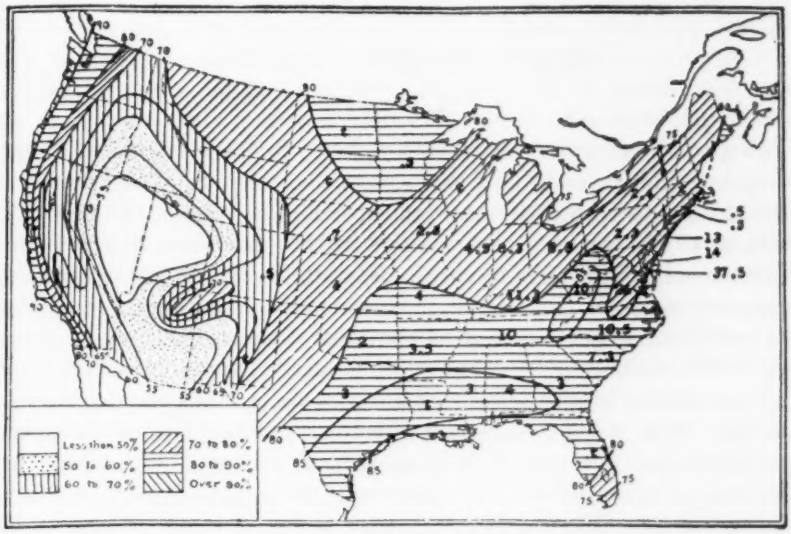

FIG. 8. July average relative humidity, 8 a. m., 75th meridian time, and percentage loss of tomatoes from Septoria leaf spot (1918–1921).

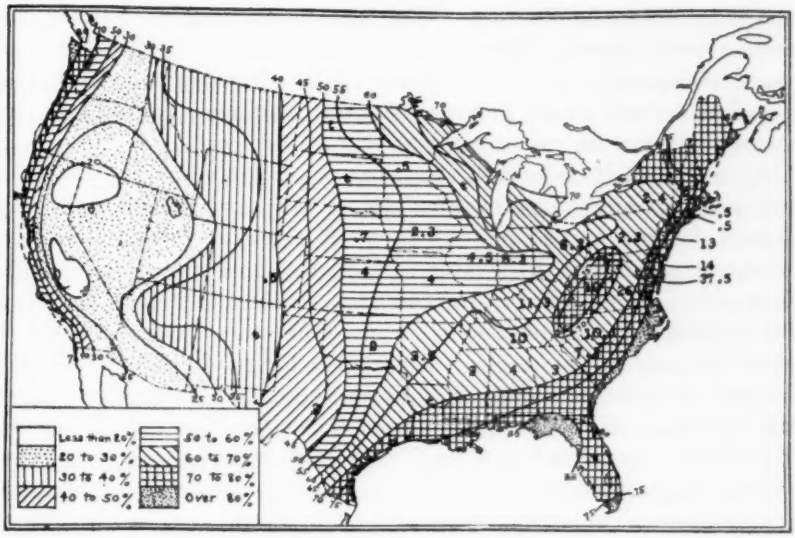

FIG. 9. July average relative humidity, 8 p. m., 75th meridian time, and percentage loss of tomatoes from Septoria leaf spot (1918–1921).

GRAPE RUST IN FLORIDA

C. L. Shear

Owing to the great interest recently shown in grape culture in Florida any information in regard to the occurrence, relative importance and, control of diseases, should be useful, especially in view of the fact that, according to the writer's observations in the past three years, fungus diseases are one of the chief factors in determining the commercial success of grape-growing in that State. Anthracnose, black rot and mildew have heretofore been regarded as the most serious diseases to be contended with in this region. Observations made by the writer on about thirty varieties of grapes being grown in the vicinity of Orlando, Florida, show that there is another disease which is perhaps more serious under some conditions than any of those already mentioned. We refer to the grape rust, *Physopella vitis* of Arthur in the North American Flora, (*Phakospora vitis* (Thüm.) Syd.) at least so far as the Florida material he includes under his name is concerned.

This is probably the same rust referred to by Burger in the Annual Report of the Florida Agricultural Experiment Station, for 1922, as found at one place in Florida. "The infection was slight but the different varieties showed differences in susceptibility." Dr. Weber of the same station in a report to the Plant Disease Survey mentions finding the rust at several places in South Central Florida. How long it has been present there on cultivated grapes is not known.

A discussion of the identity, synonymy and distribution of this rust would make an interesting chapter alone. We have not the necessary information, however, at present to settle these questions, therefore, we must leave them until a later time and a more appropriate place. Arthur gives the distribution of this rust as Florida, South Carolina, Cuba and Japan. Sydow also reports it from Jamaica in addition to the localities given by Arthur. The oldest name, *Uredo vitis* Thüm., was based on material collected by Ravenel on *Vitis vinifera* at Aiken, South Carolina. Viala, however, states that he has examined Thümen's and Ravenel's specimens and finds that they bear no rust whatever; but show simply some abnormal conditions of the host cells giving these cells somewhat the appearance of rust spores. Suffice it to say here that, whatever the original name or synonymy of this fungus may be, it is fairly well covered by Arthur's descriptions, so far as the Uredo stage is concerned, and this thus far is the only stage we have found on either

the wild or cultivated grape in Florida.[1] This rust is very common on the wild grape, *Vitis munsoniana*, from Orlando south, and has been collected and observed by the writer in many localities in Florida where this grape occurs. As to its northern distribution, we cannot say, except that we have not yet observed it on *Vitis rotundifolia* anywhere in North Carolina, South Carolina, or Georgia.

What appears to be this same rust was found in abundance on practically all of the varieties grown in the Orlando vineyards. At the time of our visit, November 10, 1923, most of the varieties had been almost completely defoliated by the rust, and we were informed by the superintendent of the vineyard that defoliation began three or four weeks previous. Judging from the very small amount of vine-growths made by most of the defoliated plants, the injury must have commenced much earlier in the season. Most of the vines had produced only short shoots with short nodes, which were certainly not capable of producing a profitable crop of grapes next season. A few of the varieties showed considerable resistance to the rust, or at least were able to hold their foliage and to make a rather satisfactory growth of bearing wood for another season. Among these were the varieties Fern, Blondin, Wonder, Royal, and Carmen. The latter variety seemed best able to withstand the attack of the rust of any of the varieties observed. This is very fortunate, as the Carmen has proven one of the most successful varieties at present grown in Florida. Judging from the effect of one or two seasons' injury by rust, most of the varieties would soon be so dwarfed and stunted as to produce little or no fruit. Since spraying for the control of rust has never been a practical success in other cases, there is little hope for any great benefit in this case. Of the other diseases mentioned, anthracnose is apparently the most serious at Orlando. While this disease can be satisfactorily controlled by pruning, dormant treatment with lime sulphur and three or four applications of Bordeaux during the growing season, the conditions of development of the vines in Florida make it necessary to make a much greater number of applications of fungicide to secure results, as there is no uniformity of development of different vines. Individual vines start growing at different times and this condition, combined with the great length of season, makes successful spraying very laborious and expensive.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

[1] Since this was written specimens showing telia and teliospores associated with the uredinia have been received from Florida.

RECOMMENDATIONS FOR THE IMPROVEMENT OF OFFICIAL INSPECTION FOR CROWN-GALL

F. C. Stewart

During the past year a committee consisting of two plant pathologists, representing the American Phytopathological Society; a horticulturist, representing the American Society for Horticultural Science; a nursery inspector, representing the American Association of Economic Entomologists; and a nurseryman, representing the American Association of Nurserymen, have made a study of crown-gall and crown-gall inspection with a view to the formulation of recommendations for the improvement of present methods of official inspection of nursery stock for crown-gall.

Following the crown-gall symposium at the recent Cincinnati meeting of the American Phytopathological Society this committee submitted the following report which was formally adopted by the Society at its business meeting on December 31, 1923:

REPORT OF COMMITTEE ON CROWN-GALL INSPECTION

1. Owing to the wide distribution of *Bacterium tumefaciens*, the large number of its host plants, and the difficulty of detecting all affected plants, official inspection of nursery stock for the purpose of preventing the dissemination of the crown-gall organism is unwarranted. The sole object of crown-gall inspection is to prevent the sale and planting of stock which will not produce a normal crop. If it be assumed that all plants affected by crown-gall are unfit for planting no method of official inspection is adequate protection for the planter, because of the nature and wide distribution of the causal agent. Inspection regulations should be framed with these things in mind and a clear distinction should be made between crown-gall and malformations due to excessive callousing, cultivation injury, woolly aphis, and nematode injury.

2. The amount of injury done by crown-gall varies greatly with different species of plants and, in some cases, even with different varieties of the same species. Also, it appears to vary somewhat with the character of the soil, methods of culture, and climatic conditions. Accordingly, it is impracticable to have uniform inspection regulations for all kinds of plants or for all parts of the United States.

3. In each state the extent of the injury done by crown-gall to the principal economic plants grown in the state should be accurately deter-

mined and the findings used as the basis of inspection regulations. Generally speaking, the persons best qualified to do this are the plant pathologists and horticulturists of the Agricultural College and the Agricultural Experiment Station. They should be consulted freely by those in charge of nursery inspection.

4. In general, the injurious effects of crown-gall have been over estimated, particularly in the case of the apple. Crown-gall injury is least pronounced in the northern and northeastern portions of the United States.

5. Crown-gall inspection regulations should describe fully, and as accurately as may be possible, the symptoms shown by plants to be rejected. To say that "all plants visibly affected by crown-gall will be rejected" is not sufficiently explicit. Hair-splitting methods of inspection are unnecessary and should not be permitted. Considerable tolerance should be allowed.

6. Field inspection for crown-gall is unreliable. The only worth-while inspection is that made at the packing shed or at the point of destination.

7. Except as a penalty for law violation, the rejection of an entire shipment because some plants in it are affected by crown-gall is unwarranted.

8. In view of the foregoing it is recommended that this Society solicit the active cooperation of the American Association of Nurserymen in a research program that will ultimately answer the questions now involved, directly and indirectly, in a better understanding of the nursery inspection problems relating to crown-gall.

Respectfully submitted,

F. C. Stewart
I. E. Melhus
M. J. Dorsey
H. F. Dietz
H. B. Chase
Committee.

On January 1, 1924, the above report was adopted by the American Association of Economic Entomologists meeting in Cincinnati, Ohio.

It is hoped that the principles enunciated in the report of the committee may be so applied by those in charge of nursery inspection as to bring about inspection methods and regulations more rational than those now in vogue.

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